

ORIGINAL RESEARCH

USE OF BINAURAL BEAT TAPES FOR TREATMENT OF ANXIETY: A PILOT STUDY OF TAPE PREFERENCE AND OUTCOMES

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Context • Recent studies and anecdotal reports suggest that binaural auditory beats can affect mood, performance on vigilance tasks, and anxiety.

Objective • To determine whether mildly anxious people would report decreased anxiety after listening daily for 1 month to tapes imbedded with tones that create binaural beats, and whether they would show a definite tape preference among 3 tapes.

Design • A 1-group pre-posttest pilot study.

Setting • Patients' homes.

Participants • A volunteer sample of 15 mildly anxious patients seen in the Clinique Psyché, Montreal, Quebec.

Intervention • Participants were asked to listen at least 5 times weekly for 4 weeks to 1 or more of 3 music tapes containing tones that produce binaural beats in the electroencephalogram delta/theta frequency range. Participants also were asked to record tape usage, tape preference, and anxiety ratings in a journal before and after listening to the tape or tapes.

Main Outcome Measures • Anxiety ratings before and after tape listening, pre- and poststudy State-Trait Anxiety Inventory scores, and tape preferences documented in daily journals.

Results • Listening to the binaural beat tapes resulted in a significant reduction in the anxiety score reported daily in patients' diaries.

The number of times participants listened to the tapes in 4 weeks ranged from 10 to 17 (an average of 1.4 to 2.4 times per week) for approximately 30 minutes per session. End-of-study tape preferences indicated that slightly more participants preferred tape B, with its pronounced and extended patterns of binaural beats, over tapes A and C. Changes in pre- and posttest listening State-Trait Anxiety Inventory scores trended toward a reduction of anxiety, but these differences were not statistically significant.

Conclusions • Listening to binaural beat tapes in the delta/theta electroencephalogram range may be beneficial in reducing mild anxiety. Future studies should account for music preference among participants and include age as a factor in outcomes, incentives to foster tape listening, and a physiologic measure of anxiety reduction. A controlled trial that includes binaural beat tapes as an adjunctive treatment to conventional therapy for mild anxiety may be warranted. (*Altern Ther Health Med*. 2001;7(1):58-63)

Use of sound for healing dates from man's earliest records. From the early 1900s, pioneer researchers have examined the effect of music on human physiology.¹ During the past few decades, increasing interest in the therapeutic effects of music on health has promoted studies of the effect of music on pain, anxiety, and mood in a variety of healthy people and patient populations, using physiologic measures as well as participant reports. In most of these studies, listening to relaxing music resulted in decreased perception of pain,² lower blood pressure and heart rate, less anxiety in response to stressful procedures, and lower scores on various anxiety scales.^{3,4} The success of music in providing comfort and reducing anxiety has resulted in the commercial production of music tapes made especially to promote a particular mood or state. These tapes have become popular as a self-help method.⁵

One type of specially created music tape uses binaural beats to facilitate mood effects. Binaural auditory beats are produced by the brain as it processes similar but distinct auditory tones presented separately through headphones into the right and left ears. When 2 different but similar pure tones are presented, one to each ear, the brain detects a phase interference between the

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tones and binaural beats are heard.⁵ The sensorial integration of the 2 frequencies produces the perception of a fluctuating rhythm at a third frequency equal to the difference between the 2 original frequencies. For example, a stimulation of 100 Hz in one ear and 110 Hz in the other ear results in a binaural auditory beat of 10 Hz, below the frequency threshold of hearing. Many anecdotal reports suggest that binaural auditory beats elicit changes in states of consciousness and mood. One study found that participants had increased performance, vigilance, and mood when presented with electroencephalogram (EEG) beta-range binaural beats compared to EEG delta/theta-range binaural beats.⁶

Furthermore, evidence suggests that binaural beats affect brain-wave EEG patterns.⁷ If brain waves are entrained by binaural beats similar to audiovisual stimulation,^{8,9} some of the reported anecdotal effects of these tapes on mood could be explained. Through brain entrainment, a 10-Hz binaural beat would encourage the brain to produce a 10-Hz beat corresponding, in this example, to a relaxed or alpha state of consciousness.

Different binaural auditory beats have been associated with sleep, relaxation, and even enhanced attention and vigilance. The delta EEG pattern (0.5-4 Hz) is associated with sleep, the theta pattern (4-8 Hz) with sleep and meditation, the alpha pattern (8-12 Hz) with mild relaxation, and the beta pattern (12-30 Hz) with attention.⁶ The brain-wave entrainment that may be associated with binaural auditory beats would create the possibility that different subjective states of consciousness could be facilitated by varying the frequencies presented to each ear. Because these binaural beats are embedded in music, the nature of the music may affect the person's mood as well. In fact, studies on the clinical use of music to improve mood have indicated that music preference may be an important factor when evaluating the effectiveness of any type of sound stimulation for clinical use. Therefore, before beginning a large double-blind clinical efficacy study on the effectiveness of binaural auditory beats, the authors concluded that additional pilot work was needed to ascertain the patient preference of tapes.

The clinical population chosen for the present study was composed of patients seeking help for anxiety disorders or states generated by situational stress. Anxiety disorders are the most frequent psychological problem in the general population. Symptoms of anxiety can appear in 3 areas: behavioral changes (such as agitation and shunning), physiological changes (such as perspiration, cardiac palpitations, and respiratory changes), and cognitive changes (such as those of anticipations and negative and unrealistic thoughts). Most current treatments for anxiety disorders use psychopharmacology or anxiolytic medications, psychotherapy, and/or relaxation therapy. Binaural beat tapes, if effective, would provide an easy, cost-effective method to help this population, and could be used by patients at home in conjunction with existing therapies.

The purpose of this study was to determine whether mildly anxious patients (with a minimum score of 30 on the Burns Anxiety Scale) would report less anxiety after listening to binaural beat tapes daily for 1 month, and whether they would show a clear preference toward one of the particular binaural beat tapes

used. This information would be useful in designing a larger double-blind efficacy study. This study would also bring to light any other issues that might be of concern in a larger efficacy study.

MATERIALS AND METHODS

Tapes

The investigators used 3 music tapes with audio tones that give rise to binaural beats. These tapes were commercially produced and were recommended for use for anxiety. The tapes were labeled A, B, or C, and their titles were blinded from patients and researchers. The 3 tapes selected were different in terms of tones that produce binaural beats, and also in terms of music. Each tape was 30 minutes in length; these tapes are available from the Monroe Institute, Faber, Va. Analysis of the frequency spectrum of left-right differences in stereo audio signals over time was performed on each of the 3 tapes. Analyses revealed the following evidence of the different embedded binaural beat components on the tapes:

- Tape A, "Higher," was strongest in delta binaural beats, with some low theta in the middle and the end.
- Tape B, "Into the Deep," had a strong low theta binaural beat component, as well as a delta component and some high theta/low alpha (7.5-8 Hz). Overall, "Into the Deep" showed a more pronounced and extended pattern of binaural beats.
- Tape C, "Sleeping Through the Rain," was strongest in delta, but showed a less pronounced pattern of binaural beats than did tapes A or B.

Subjectively, the listener perceived instrumental music in all 3 tapes. The background of instrumental music hid the perception of binaural beats and promoted comfortable conditions for relaxation.

Participants

The researchers recruited 17 volunteers from patients seeking treatment for anxiety at the Clinique Psyché, Montreal, Quebec. The volunteers had a minimum score of 30 on the Burns Anxiety Scale and were mildly anxious. They were not considered acutely ill and were not using medications for their anxiety for the study duration. Subjects were informed that the tapes produced "different sounds in each ear" (binaural beats), and that the effect may be a reduction in their level of anxiety. They also were told to use headphones and not to use noise reduction or filter (such as Dolby).

Two female participants dropped out of the study: one because she did not like the intervention and a second because she could not find time to listen to the tapes. Fifteen of the 17 recruited volunteers completed the protocol (3 men and 12 women). All participants were employed; their mean age was 40 years, with a range from 23 to 57 years. The study was approved by the ethical committee for research projects at the Maisonneuve-Rosemont Hospital in Montreal. Participants reviewed and signed the informed consent form prior to participation in the study. Subjects did not receive any remuneration for their involvement in this study.

Anxiety Scales

Burns Anxiety Scale. Participants filled out the Burns Anxiety Scale to determine eligibility for the study. This test served as an objective criterion to determine level of anxiety or stress. The inclusion threshold was fixed at 30, a score corresponding with mild anxiety. The Burns Anxiety Scale is a 4-point Likert-type scale of 33 items associated with emotional (1-6), mental (7-17), and physical (18-33) anxiety. This inventory was administered during an informal meeting with each study volunteer; those who scored 30 or higher were asked if they would like to continue in the study.

State-Trait Anxiety Inventory. The State-Trait Anxiety Inventory (STAI) was used to assess changes in anxiety before and after the study, as a measure of the effects of 4 weeks of listening to the tapes. The STAI contains 2 x 20 items (4-point Likert-type scales) that describe feelings of anxiety. Item ratings can be summarized on 2 standard scales that represent state and trait anxiety. The state-anxiety scale consists of 20 statements that evaluate how respondents feel "right now, at this moment." The trait-anxiety scale consists of 20 statements that assess how respondents feel "generally." The STAI differentiates between the temporary condition of "state anxiety" and the more general and long-standing quality of "trait anxiety." The essential qualities evaluated by the STAI state-anxiety scale are feelings of apprehension, tension, nervousness, and worry. Scores on the state-anxiety scale increase in response to physical danger and psychological stress, and decrease as a result of relaxation training. On the STAI trait-anxiety scale, consistent with the trait anxiety construct, psychoneurotic and depressed patients generally have high scores. The STAI was administered at the first meeting with participants and 2 weeks after the last tape listening.

Journal Anxiety Scale. Participants were asked to rate their anxiety before and after each tape-listening session using a 0-to-100 scale (0=not anxious at all; 100=most anxious possible). After study completion, each subject's anxiety ratings for all sessions were first averaged before and after listening to each particular tape; these means were used for statistical analysis, so that each subject contributed 1 data point for mean anxiety level before and 1 data point for mean anxiety level after each tape. Each participant's ratings thus contributed equally to the overall averages for anxiety ratings before and after tape listening.

Tape-listening Diary

Participants were given the 3 tapes (labeled tape A, B, or C) to listen to over a 4-week period and were asked to keep a daily journal of tape use and anxiety ratings before and after listening. They were asked to listen to a tape of their choice every day or at least 5 times a week. Subjects also were asked to write in their journal daily and to record the tape they selected, the date and time, the number of minutes they listened, whether they were interrupted during the listening period, and the anxiety rating before and after listening. They were asked to record any other comments they wished to include.

RESULTS

Tape-listening Sessions

In general, participants were favorable about the tapes and

the journals in which they made daily recordings. Although participants consented to listen to a tape every day for 4 weeks (for a total of 28 times), their average actual listening time was only half of what was requested in the protocol (Figure 1). The number of times in 4 weeks participants listened to the tapes ranged from 2 to 28 times, with an average of 14.6 times. Eight of the 15 participants listened between 10 and 17 times in 4 weeks, or an average of 1.4 to 2.4 times per week. Two people listened 5 times, and 3 listened 19 or 20 times in the 4 weeks. One participant listened 27 times, and 1 participant listened to a tape only twice—her data were removed from further analysis. Therefore, the number of participants for further analysis was 14. The average duration of tape listening was approximately 30 minutes per session, with no significant differences in listening duration among the 3 tapes. The average number of times participants listened to tapes in a week dropped from 4.4 times in the first week to 3.0 times in week 4. Four of the 14 participants did not listen to any tapes the last week of the study.

Tape Preference

Tape A was listened to 59 times, an average of 4.2 times per subject; tape B was listened to 73 times, an average of 5.2 times per subject; and tape C was listened to 73 times, an average of 5.2 times per subject. These differences were not statistically significant, but according to the participants' verbal preference and comments, a general preference existed toward tape B, "Into the Deep," with tape C, "Sleeping Through the Rain," second in preference. Five people expressed a preference for one particular tape: 3 subjects preferred B, 1 preferred C, and 1 preferred A. Four participants expressed preferences for pairs of tapes (2 for A and B and 2 for A and C), and 3 people liked all 3 tapes with no expressed tape preference. Two subjects expressed no tape preference.

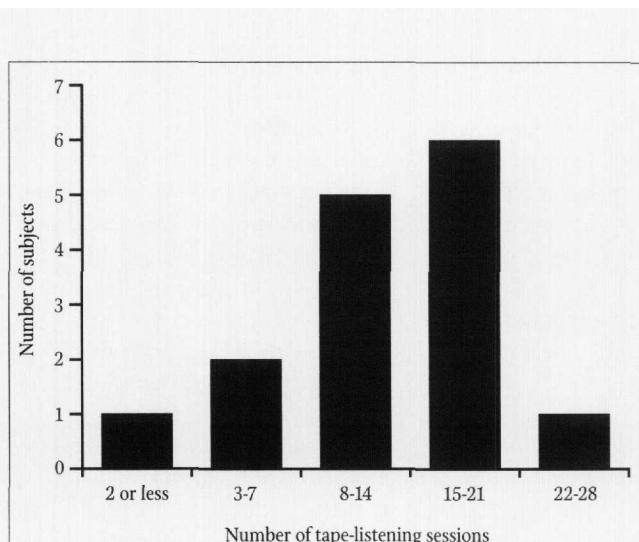


FIGURE 1 Number of subjects grouped by frequency of tape listenings over 4 weeks

These tape preferences were determined from the participants' stated preference at the end of the study or from their journal comments. Counting multiple preferences, 8 participants expressed a positive response to tape B (B, A/B, B/C, or A/B/C), 6 subjects indicated a positive reaction to tape A (A, A/B, A/C, or A/B/C), and 6 subjects had a positive response to tape C (C, A/C, A/B/C). Study participants who showed a preference to tape B did not prefer or like tape C, and vice versa. Those who had no special preferences reported liking all tapes equally. Tape A was listened to the most by 1 participant, tape B the most by 6 participants, and tape C the most by 4 participants. Three participants listened equally the most number of times to a pair of tapes (A/B, B/C, and A/C).

Although tape B was preferred by more participants, 2 of the 14 participants did not like it and did not report any relaxation from listening to it. Three people did not like tape C and only 1 person said he did not like tape A. Several people made the comment that the base sounds at the beginning of tape A were aggressive and bothersome, and made it difficult to relax. One person turned down the base on her stereo system to tolerate tape A, and liked it after that adjustment. In a preliminary coding of positive and negative comments by tape, 27 positive and 5 negative comments were recorded about tape B (with multiple comments by the same person). Eleven positive and 6 negative comments were recorded about tape C, and 14 positive and 6 negative comments about tape A.

Daily Anxiety Ratings

Data in Figure 2 show the average anxiety ratings before and after participants listened to tapes A, B, and C. Each participant's data were first averaged for each tape to yield 1 data point for each of the 14 participants. Use of all 3 tapes was associated with reduced anxiety and the difference in participants' prelistening and postlistening scores was statistically significant for all 3 tapes using a matched pairs *t* test ($P < .001$, $P = .001$, and $P < .001$ for tapes A, B, and C, respectively).

The State and Trait Anxiety Inventory

The STAI served as a pre- and posttest. Difference in STAI scores are shown in Figure 3. These changes for both state and trait anxiety trended toward a reduction after 4 weeks of the study, but these differences were not statistically significant.

Participant Comments

All participants wrote comments in their journals after listening to the tapes. The most frequent comments were about enhanced relaxation and falling asleep. Many indicated that the relaxing effect of the tapes occurred sooner within the listening time as the study progressed. They reported that being relaxed helped them to experience sleep onset faster, to sleep better, and to awake more rested. Many comments indicated that participants had a hard time staying awake when listening to the tapes, and they sometimes reported that they fell asleep with the tape still running. A few had negative comments about a particular

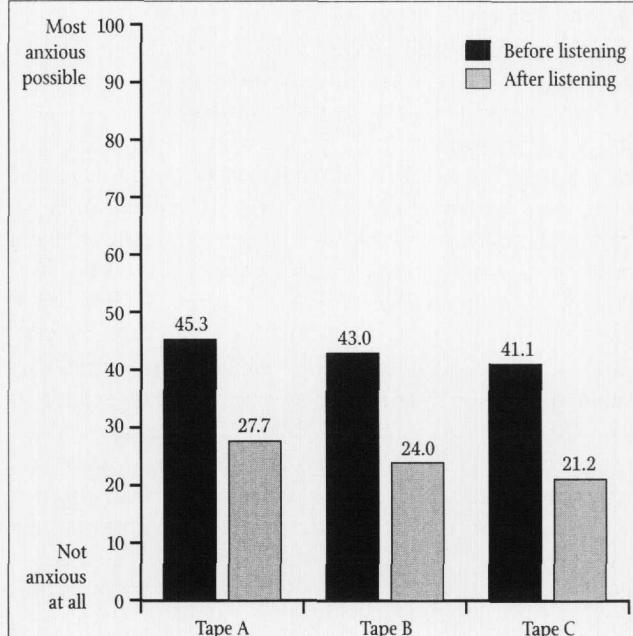


FIGURE 2 Average anxiety ratings before and after each session

tape, and reported that listening to it made them uncomfortable or agitated, or made it harder to relax. Many participants reported that listening to a tape every day was a burdensome directive that they could not follow or sustain for a long period of time.

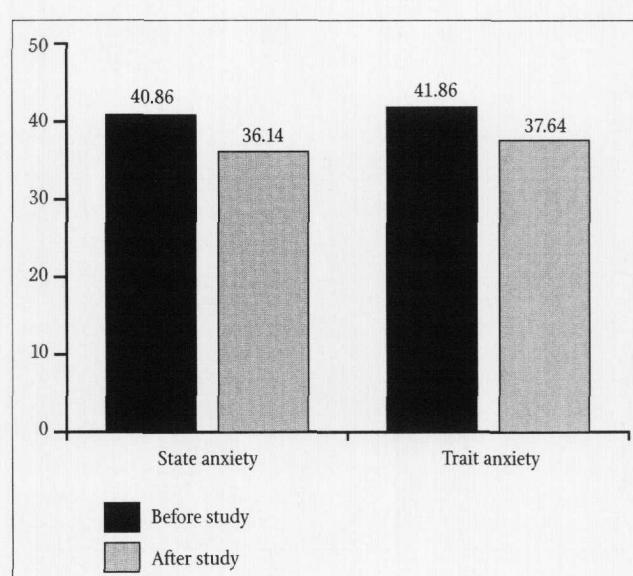


FIGURE 3 Average state-trait anxiety ratings before study and after 1 month of listening

Age and Anxiety Ratings

A moderate negative correlation was observed between age and reduction of anxiety ratings reported in the journals after listening to all tapes ($r=-.5, P<.05$). For exploratory purposes, participants were divided into 2 age groups—*younger* (aged less than 40 years, $n=7$) and *older* (aged more than 40 years, $n=7$)—and the effects of age were examined. There was an effect of age on changes in anxiety ratings reported after listening, with younger participants reporting an average reduction of 27.9 points, from 41.3 to 13.4, and older subjects an average reduction of 9.8 points, from 44.9 to 35.2 (Figure 4). This difference was significant ($P<.004$), though the small number of participants contributing to this analysis should be taken into consideration in evaluating the reliability of this effect. This result suggests that future studies should evaluate the influence of age on binaural beat treatment effects to determine whether age effects exist in a larger study population. Also, this trend was not evident in the STAI ratings.

If an arbitrary cutoff of journal-reported anxiety score reduction of greater than 15 is used for any tape to indicate a “tape responder,” 4 “tape nonresponders” existed in this pilot study (where none of the tape sessions resulted in reduction of anxiety of greater than 15 points on the 100-point scale). All 4 of the participants were in the over-40 age group. Furthermore, 4 participants showed good responses to all tapes (greater than a 15-point anxiety reduction with all 3 tapes). Three of these 4 participants were in the under-40 age group.

DISCUSSION

The purpose of this pilot study was to determine whether listening to music tapes with embedded audio tones that give rise to binaural beats would be effective for reducing mild anxiety, and whether one of the binaural beat tapes would be clearly preferred by the sample of mildly anxious patients. This pilot study also served to reveal issues that would be of concern in a larger efficacy study.

The results of this study suggest that music with embedded audio tones in the delta/theta frequencies reduced anxiety in this mildly anxious population. In many cases, reductions in anxiety mirrored verbal preference for a tape, but occasionally participants stated preference for a tape that was not associated with the largest reduction in their anxiety report. Although each of the tapes was preferred over the others by some participants and each of the tapes elicited negative reactions from others, overall, tape B, “Into the Deep,” received more positive comments, and was stated as the preference by more study participants than were the other 2 tapes. Tape B had a strong low theta binaural beat component, as well as a delta component and some high theta/low alpha (7.5-8 Hz). Overall, it had a more pronounced and extended pattern of binaural beats than did the other tapes.

Whether tape B was the preferred tape because of the music component, the binaural beat component, or both is not known. The results, the small sample number, and the study design do not permit the investigators to answer this question. From these results it cannot conclusively be affirmed that there is a strong general preference toward 1 of these 3 tapes by mildly anxious persons. What is clear, even in this small pilot study, is that people have different preferences that must be considered in future studies. Music therapists often indicate that it is important to meet the tempo of the patient with the music selection for optimum therapeutic benefit to occur.¹⁰ Results from this pilot study suggest that a set of at least 2 tapes should be used in future studies to provide tape variety and to respond to different listening preferences among study participants.

One problem encountered in this pilot study was the lack of adherence of participants in listening to the tapes every day for the 4-week study duration. Some participants reported negative reactions to particular tapes that affected their willingness to listen, and some had difficulty listening as often as the protocol specified. Reductions in anxiety after listening to these tapes may have been greater if participants had listened to a tape at least once daily. Therefore, finding a way to encourage adherence to the listening protocol for the study duration is an important consideration for any future study. The investigators learned that asking study participants to listen to tapes 7 times a week is an unrealistic expectation. A possible solution would be to encourage daily listening, but to specify that 5 times per week at a minimum may yield improved adherence to the protocol. Incentive for finishing the study would probably increase protocol adherence as well.

Another potential problem was a possible order effect that may have been present in the tape listening sequence,

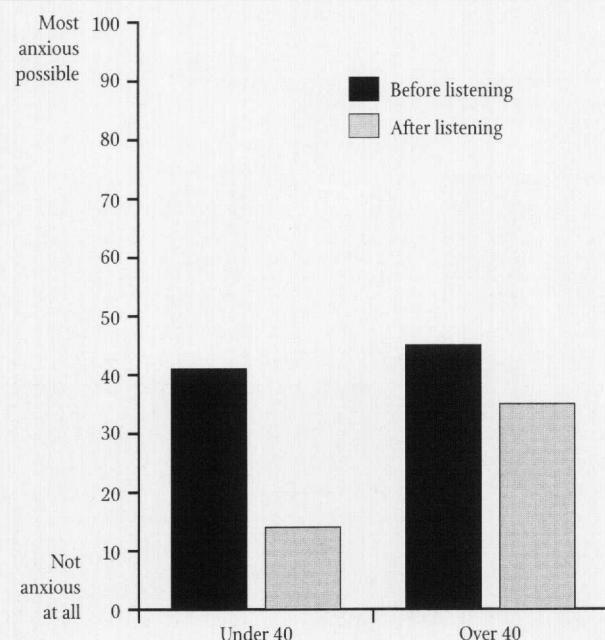


FIGURE 4 Age effects on average anxiety reduction through tape listening

especially during the first week of the study, as the tapes were labeled A, B, or C. Many, but not all, participants listened to tape A first. However, after participants had listened to all 3 tapes (by the end of first week), tape choice was made according to listening preference and the order was different for each person. Still, it may be better to randomize the tape blinding codes in future studies to eliminate the possibility of order effects in listening.

Results of this small pilot study suggest that presentation of audio tones embedded in music that give rise to binaural beats may reduce anxiety in a mildly anxious population. Significant reduction in anxiety ratings after listening to tapes, along with participant report that the relaxing effects were noticed more quickly the more days they had listened to tapes, suggests that repeated exposure to these tapes may result in an improvement in the ability to relax. Participants also reported better ability to sleep and feeling more relaxed upon waking. However, due to the small number of study participants, these results may not generalize to a larger population.

These tapes appeared to be more effective in relieving the anxiety of younger persons than older persons. One reason for this may be that older persons with anxiety have had their condition longer, and may therefore be more difficult to treat effectively with short-duration therapy. Another reason may be that the hearing of older persons may not be as acute as that of younger persons, and therefore may not have experienced the same brain integration and perception of binaural beats as the hearing of their younger counterparts. This effect may also have been due to the small sample size of the 2 age groups ($n=7$), as well as the particular composition of the group, and therefore may not be reproducible.

It cannot be determined whether it was the binaural beats that elicited the increased relaxation, or the music, or nonspecific treatment effects. To answer these questions, a double-blind study design would be needed that would compare the efficacy of music with binaural beats compared to the same music without binaural beats. To test the efficacy of different binaural beats, the tapes would also need to have differing patterns and frequencies of beats. It would also be advantageous to establish a correlation between a standardized psychological marker for anxiety and an objective physiological marker of the binaural beat stimulation, such as the EEG (a study in progress). Changes in salivary cortisol before and after listening, along with changes in the STAI, may be a more appropriate outcome measure of anxiety in future studies. Such studies are warranted and would better address questions of the therapeutic efficacy of binaural beat stimulation.

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